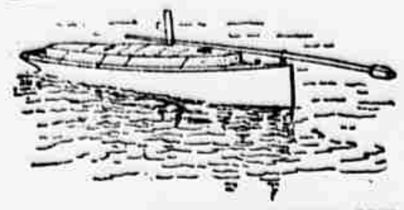
SPEED OF TORPEDO BOATS.

EVOLUTION OF MODERN VESSELS FROM THE STEAM LAUNCH.

Development of Speed from 18 1-2 Statute Miles an Hour in 1863 to 27 2-5 Knots at the Present Time—The Nibbio, Built in Prussia for the Italian Government, Maintained 26 3-5 Knots for Three Hours—The Norwood and Vamoose are Far Behind These Boats in Their Speed.

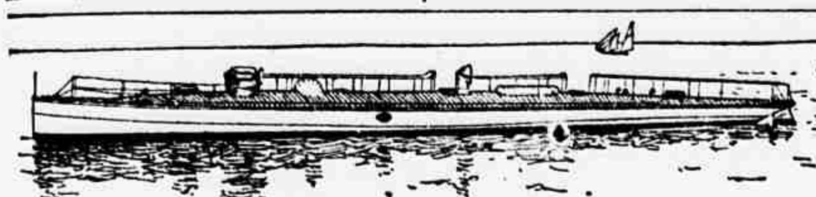
When one becomes interested in the speed of the fastest boats known in the various stages of naval architecture, and takes up a study of the subject of high speeds, he soon finds himself practically confined to one kind of craft. Up to the present time, when in this country the development of speed has taken a turn in the direction of the steam launch, all of the advances in the way of producing the swiftest steam craft possible at any period have been made in torpedo boats. These in-



STEAM LAUNCH, CARRYING SPAR TORPEDO—1872.

teresting little flyers lead the world in speed, and have taught many valuable lessons to naval architects. The public mind has not found it a difficult task to keep up with their development and growth. True, the American public knows less about these boats than any other nation, but that is because we have built in this country two boats, of both of which our navy is the proud possessor, while in England hundreds have been launched and in France and Prussia hundreds more have come into existence.

The United States Government seems more friendly now toward the building of a fleet of torpedo boats than for years, but this Government cannot take any part of the credit for the rapid strides made in the last thirty years. That belongs largely to England, the home of these boats. France and Prussia have much to be proud of, especially the latter country, which stands at the head in speed; but, notwithstanding this, England carries off the palm in the development of the torpedo boat as an implement of warfare.

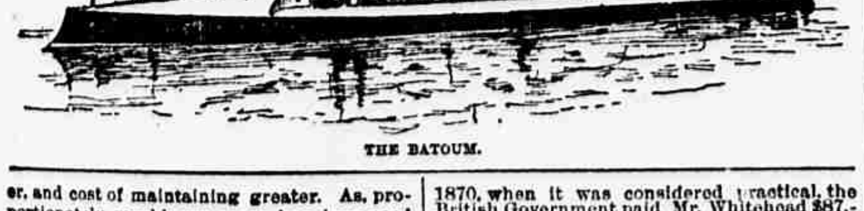


BOAT BUILT IN 1879.
Speed 21.93 Knots.

The especial use of this style of craft in time of war is in defensive work. It would not be a wise move to send torpedo boats into the ports of an enemy at any great distance and expect them to wage war alone, but with a fleet of these boats to guard our coast we would stand in little danger of having our seaboard cities destroyed by an enemy's ships. We could acquire such defensive equipment at comparatively small cost and in a very short space of time. While a gunboat would be an unwieldy craft down the bay, a few torpedo boats could dart hither and thither, discharging their weapons with telling effect and doing deadly work in the narrow channel.

The effectiveness of a defence by torpedo boats has received great attention and study in naval circles all over the world, and is now generally believed to be sufficient to warrant the building and maintaining of fleets. A craft 130 feet long, armed with four torpedoes and two machine guns, capable of making 25 knots an hour for eight or ten hours and with power to stop from full speed in about twice her own length, as well as to complete a circle at full speed, the radius of which is not longer than her own length, is a tidy one, to say the least. A dozen such boats in New York could hold an enemy in check for days.

Speed in a torpedo boat is one of its most important features, and in the development of high speed the designer is not hampered as he is with a transatlantic liner. Indeed, the main reason for torpedo boats leading the world in speed is because they are the only craft where profit to the owner is not in dollars and cents, but in effectiveness as an implement of war. In the modern transatlantic liners profit to the owner is about the first problem solved by the naval architect. It is probably within the range of possibility to build a steamer that will cross the Atlantic in four days, but it has not yet been shown that such a ship would be profitable, and consequently capital is not at hand to produce it. As a matter of fact, there is still doubt about the practicability, from a financial standpoint, of crossing the ocean from Queenstown to New York in five days. In the first place, the present rate of travel has been acquired by a constant development of conditions which place more and more of a risk on capital. The ships have been growing larger and more costly, but in proportion to their size their displacement is less than the older ships, cargo capacity is less, machinery space great-



THE BATOUM.

er, and cost of maintaining greater. As, proportionately, machinery space has increased and displacement has grown less by reason of finer lines for speed than used to be drawn, it has been found necessary to increase passenger accommodation to make up for the small cargo capacity and great expense of running. In driving the City of Paris or Majestic across the Atlantic in less than six days there comes a tremendous strain on their engines and hull, so that it is not known how many years the capitalists owning the ships have in which to get back their investment as well as interest. The cry is for fast ships, and this demand leaves the slower ones to act as freight carriers, thus cutting off a percentage of their intended profits from passenger service. Competition has prevented an advance in the rates in fast ships, and, notwithstanding the great cry for speed across the Atlantic, it can be put down as a fact that with present rates and conditions the financial world, which is alone responsible for the "ocean greyhounds," still considers them as experiments, and hopes the Columbian Exposition of 1893 will solve the great problem of their practicability.

A word more bearing on this subject will hardly be out of place and may give a clearer perception of the difficulties in the way of going to the limit of speed in a steamship. Admitting that forty knots could be obtained and maintained, which is hardly too great a speed in the eyes of naval architects, it would take, according to recent figures, 160,000 indicated horse power, 70 boilers, and a coal consumption of over 2,000 tons per day to do it. For an increase of 19 per cent. in speed over 21 knots the City of Paris would need an addition of 70 per cent. to her power. In a six days' voyage the City of Paris burns about 1,900 tons of coal. As compared with the Britannia, the original Cunarder, the City of Paris has engines with 20,000 indicated horse power and carries 2,500 tons of coal, while the Britannia had 740 indicated horse power and only 600 tons coal capacity. The City of Paris has a cargo space only a trifle larger than the Britannia, the extra cost of running being made up by increased passenger accommodation. The indicated horse power of the engines of the two new Cunard ships which will be ready for use in 1893 is 30,000, and this is to produce a speed of 22 knots.

Speed in passenger ships is limited by financial restrictions, in gunboats and armored cruisers it finds a natural limit by reason of heavy construction and armor as well as other causes, while in torpedo boats it has all the liberty possible with restricted displacement. In the torpedo boat high speed is one of the principal aims, so that it has here had a chance of development, but even in this style of craft it is not practical to try and determine how fast a body can be moved through the water, for the speed of boats is in a measure dependent upon their size; that is, extra speed may be obtained by increasing the displacement and increasing the power in direct proportion to displacement, with similar machinery and without improvements. Consequently the size of torpedo boats being limited by their usefulness, the highest possible speed that could be developed at the present time is not sought after. What is desired and worked for, however, is the highest speed possible on a given displacement, and it may be said that here science has full sway. The experiments with torpedo boats show how to develop speed and reveal somewhere near the limit which could be reached at the present stage of science, but for a nation or a set of capitalists to build a monstrosity for the sake of speed alone would be obviously absurd. It is enough to develop as much speed as possible where it can be utilized, as in a torpedo boat, leaving naval architects and engineers to calculate from results obtained the greatest velocity that could be attained.

As far as speed goes, then, the evolution of the torpedo boat has been a refinement of model and a steady increase in the proportion of power to displacement, together with the invention and perfection of mechanical appliances that contribute to the general result.

The modern torpedo boat is the outgrowth of the steam launch, and may be safely said to have begun with the launch Ariel, built in 1863 by the famous John I. Thornycroft of England. Previous to 1860 Mr. Thornycroft became interested in launch building, and he took up the study of boilers, carrying on experiments in the way of harnessing the power of steam. He was a classmate at Oxford of Frank Willan, a well-known English yachtsman, and the support of Mr. Willan did much toward giving Mr. Thornycroft his start.

The Ariel was the first steel launch built in England, and she proved to be a sensational craft. She was 41 feet long, 5 feet 6 inches beam, and drew about 21 inches of water. Her steel plating was 1-40 of an inch in thickness, her engines were of the simple high-pressure type, and she was fitted with a locomotive boiler. This little craft made 18½ statute miles an hour, a speed that attracted the attention of many men of science.

Mr. Thornycroft continued to experiment with steam launches until in 1871 he built the Miranda, a launch that was first used at the Henley regatta on the Thames as umpire's boat, and attained a speed of 16.8 statute miles per hour against the stream, with 100 pounds pressure of steam. Her effective speed was about 18.4 miles. Her dimensions were: Length, 49 feet 9 inches; breadth, 6 feet 6 inches; maximum draught at full speed, 2 feet 6 inches. She had a locomotive boiler and her engines had two cylinders, each 6 inches in diameter, with 8 inches stroke. One interesting discovery made in the Miranda was that up to 14 miles an hour she behaved like any other boat, but above this speed her transverse wave was left astern and she was seen to mount and travel with her own wave, hereby attaining a natural position for doing her best work. This discovery was important, as it revealed a new advantage to be sought.

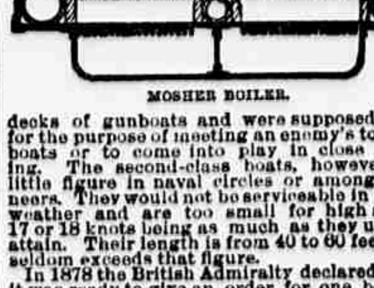
Steam launches no sooner demonstrated their ability to maintain high speeds than the idea suggested itself of their being utilized in some way as implements of war. Their most effective work seemed at once to be in handling torpedoes. The Admiralty of Great Britain fitted a number of them with spar torpedoes, and experiments proved that this type of boat was, by reason of its usefulness, entitled to encouragement.

Besides John I. Thornycroft there had come into the field of building by 1871 a number of firms, conspicuous among whom from the start was Yarrow & Co. of London, A. F. Yarrow being at the head. Since 1878 Yarrow & Co. and John I. Thornycroft & Co. have led all English builders, and have between themselves been fighting about nip and tuck for first place. Americans are familiar with both firms, although few in this country appreciate what great strides they have made in naval architecture and engineering. In all their advances they have worked on somewhat different lines, so that both Mr. Yarrow and Mr. Thornycroft can lay claim to originality, and each can say with truthfulness that he has given to the engineering world valuable inventions and lessons in boat building. It is a pleasure to be able to record that these engineers have been practical in all their undertakings, and by feeling their way they have made no disastrous mistakes. If either had been flighty, and had sought to make a sudden jump from eighteen to thirty miles an hour in speed, he would have been called a crank, and would not have received encouragement. It is because they have been practical that the naval experts of the leading naval powers of the world have really been compelled to contribute to their progress by buying boats. The engineers have also had to keep pace with the torpedo.

With the invention of the machine gun it was thought that the days of the torpedo boat were numbered. The little launches carrying spar torpedoes would stand little chance of living through the fire of a machine gun, and it was evident that something must be done to counteract the effect of the new weapon. This was a trying time for the little fighters, but their success was assured for all time with the invention of the Whitehead torpedo which could be discharged at an enemy from some distance away. It only remained now to invent a way to manage this torpedo satisfactorily, and to augment the usefulness of the boats by increasing their speed and size and at the same time making their movements more active. That is, it was essential that they should get up steam in a hurry, start and stop quickly, and turn in a small circle when going at any degree of speed.

Torpedoes were invented in 1776 by Capt. David Bushnell, who in the war of the Revolution tried to destroy several British ships, but was unsuccessful. Robert Fulton, inventor of the steamboat, was the first to use a torpedo successfully. In 1801 he blew up a French vessel at Brest, his weapon being a drifting torpedo of his own make. The value of torpedo boats in actual warfare was not demonstrated until our civil war, and then foreign Governments took up the matter seriously, Mr. Thornycroft's Miranda paving the way for rapid strides. Mr. Whitehead began experimenting with his locomotive torpedo in 1864, and in 1870, when it was considered practical, the British Government paid Mr. Whitehead $87,000 for the right of manufacture.

In 1877, the only first-class boat in the English navy was the Lightning, built by Mr. Thornycroft. This boat is known as "No. 1" in the British service. She is 84 feet 6 inches long, with 10 feet 10 inches beam, and she made 19 knots. Torpedo boats were then divided into two classes. Those of the first class were supposed to be independent, seagoing vessels, although a thoroughly seaworthy one had yet to be built. The second class comprised boats that were used as auxiliaries to gunboats and cruisers and also about harbors. They were hoisted to the

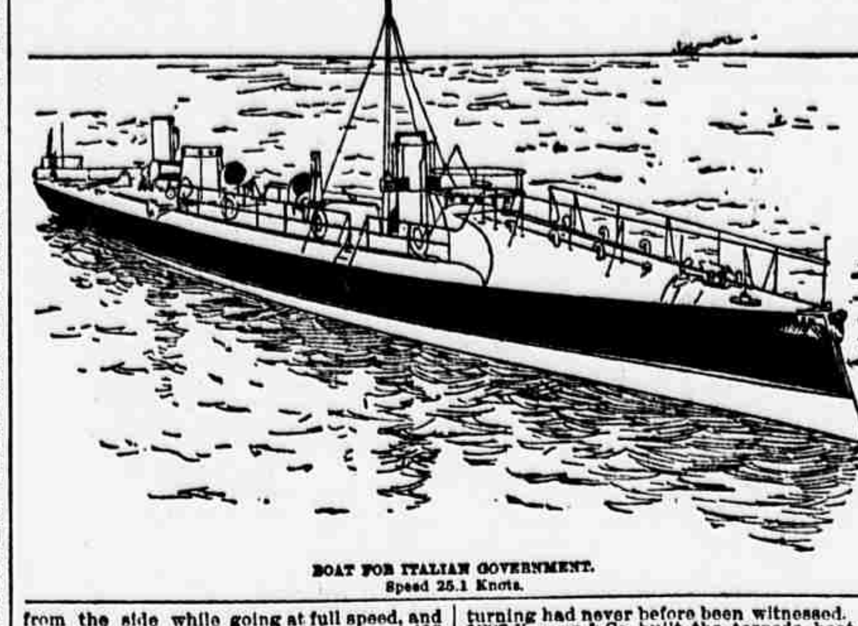


MOSHER BOILER.

decks of gunboats and were supposed to be for the purpose of meeting an enemy's torpedo boats or to come into play in close fighting. The second-class boats, however, cut little figure in naval circles or among engineers. They would not be serviceable in rough weather and are too small for high speed. 17 or 18 knots being as much as they usually attain. Their length is from 40 to 60 feet, and seldom exceeds that figure.

In 1878 the British Admiralty declared that it was ready to give an order for one boat to any firm willing to build, there being certain conditions as to size, mode of trial, &c. About eight firms offered to build one each, and in this contract the two firms of Yarrow and Thornycroft were brought into competition. The result was a victory in speed for the Yarrow boat, which developed a velocity that was at that time considered remarkable. The trial occurred in March, 1879. The boat was 86 feet long and carried a load of 6¾ tons. The steam pressure was 124 pounds. Three runs over the measured nautical mile were made with the tide and three against it in the usual way, the mean speed being 21.93 knots, or about 25¼ statute miles. A peculiar feature of this craft was the absence of a smokestack. The gases escaped through a hole in the side, this method being designed to make her less likely to be seen by an enemy. There are many who still think this an advantage, although it was abandoned years ago.

In the year following Mr. Thornycroft came out with another boat which was very fast, but did not quite come up to the performance of the Yarrow boat. The new Thornycroft craft was 90 feet 6 inches long by 10 feet 10 inches beam. Her armament consisted of three Whitehead torpedoes, two being carried on transporting carriages on each side of the deck, and one in a torpedo gun in the bow. The gun was arranged so it could be turned to discharge the torpedo on either side or over the stem, preference being given to firing



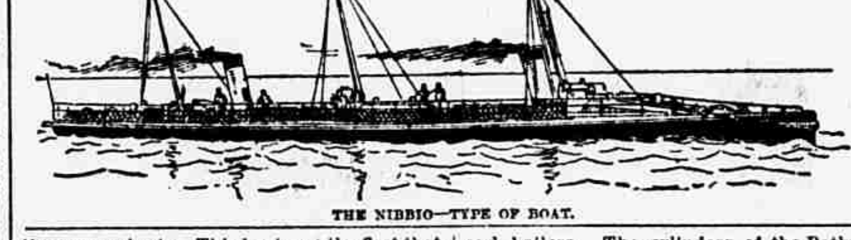
BOAT FOR ITALIAN GOVERNMENT.
Speed 25.1 Knots.

from the side while going at full speed, and there was almost a certainty of hitting at 400 yards. The ejecting apparatus consisted of a telescopic impulse-tube, actuated by compressed air. On earlier boats torpedoes had been launched from frames at the sides, but this method was unsatisfactory, inasmuch as speed had to be reduced to three knots in order to operate the torpedo successfully.

On a preliminary trial on the Thames the new Thornycroft vessel made 22.01 knots mean speed over six miles, with 3¾ tons on board, but on her official trial with 6¾ tons on board, Feb. 28, 1880, this fell to 21.75 knots. The power was 469 indicated horse power.

The year 1880 was also marked in torpedo boat building by the appearance of the Batoum, which Messrs. Yarrow & Co. constructed for the Russian Government. This was really the first seagoing boat of the kind. She was 100 feet long, with 12 feet 6 inches beam and 3 feet 6 inches draught of water. On her trial a speed of 22 knots was attained. She was provided with three short masts, easily stowed away when not wanted, and was thus able to go it alone in case of a breakdown of her engines. She carried about ten tons of coal, which was enough to make a run of 800 miles at a speed of 10 or 12 knots. The stem formed a sharp ram. Under the deck forward were two launching tubes projecting outside the bows, each with a Whitehead torpedo ready for firing, and two extra torpedoes were also carried. The boat was steered from the conning tower when in action, and from the deck at other times. She had two rudders, one a balance rudder, placed under the bow. This made her quick to obey her wheel, and it was found that she had great manœuvring capabilities. Her seaworthiness was satisfactorily tested when she made a voyage, soon after she was built, to the Black Sea. The distance covered was 4,800 miles, and the Batoum made the voyage in eighteen days, exclusive of stoppages, being an average speed of eleven knots. This little vessel was so successful that Yarrow & Co. received orders for boats of the Batoum type from the Argentine, Brazilian, Greek, Austrian, Dutch, and Italian Governments. Four of the boats built for the Argentine Government were rigged to cross the Atlantic under sail alone, and one, the Alerta, made the voyage from Plymouth to Buenos Ayres in 72 days. Very rough weather was encountered, but the boat behaved admirably.

In a boat built for the Italian Government Yarrow & Co. again topped the record for speed with 22.46 knots. The official trial was held on the Thames in December, 1881, and the boat carried her torpedo apparatus completely fitted on board. She was of the Batoum type, 100 feet long and 12 feet 6 inches beam. The engines during the trial made 480 revolu-



THE NIBBIO—TYPE OF BOAT.

tions per minute. This boat was the first that was fitted with Yarrow's patent arrangement for preventing the fire from being extinguished in case water gained access to the stoke hole or boiler compartment. In the face of machine guns on an enemy's ship this invention was most valuable. The ashpan was continued up around the firebox to above the sea outside, and secured water tight to the barrel of the boiler, the fire door also being water tight. Thus, if water got into the compartment it could not get at the fire, and the boat could run many knots before steam was exhausted.

The year 1883 brings us into another phase of torpedo boat development—that of boilers. Up to this time the locomotive boiler had been used, together with compound engines with two cylinders. In 1883 the first Thornycroft tubulous boiler was fitted to the steamer Peace, built for the Baptist Missionary Society for use on the Congo in Africa. It was a singular incident that the first of a type of boiler that has commanded the attention of the whole engineering world should be tested in the heart of the Dark Continent. Nevertheless, such was the case, and after five years Mr. Grenfell, the missionary in charge of the boat, reported that "the boiler is doing splendidly, and we have no trouble in keeping up sufficient steam for 400 revolutions."

As the question of the tubulous versus the locomotive boiler is a live issue to-day, many believing that the former will take the place of the latter on boats making long voyages, it will not be out of place to reproduce the words of John Donaldson, who is associated with Mr. Thornycroft, spoken on Feb. 15, 1889, before the Royal United Service Institution.

"I may fairly claim," said Mr. Donaldson, "that we were the first to use the locomotive boiler as a marine boiler. As time went on, however, and greater demands were made for steam, without any possible concession in the way of weight, the locomotive boiler, with its straight tubes and tube joints in close proximity to a fierce fire, showed signs of distress. Tubes leaked, and that persistently, priming occurred to an extent that frequently baffled all our efforts to continue a trial, and in a way that was most puzzling. Skill in the working of the boilers was a great consideration, and an experienced stoker (fireman) made a wonderful difference in a trial trip, not only in the keeping of steam, but in insuring that the ordinary difficulties might not be greatly enhanced by the addition of a boiler explosion."

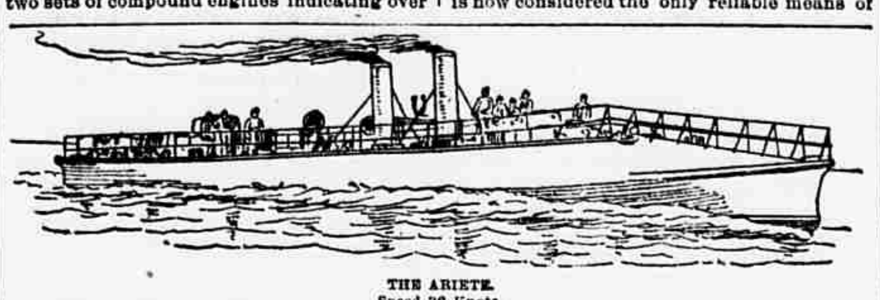
With a passing reference to several boilers of different types, Mr. Donaldson explained the Thornycroft boiler in detail as it is known to-day. It consists of three cylinders lying parallel to each other, the two smaller being at the base and the larger one at the top. These cylinders are rigidly connected by means of two large tubes at the fire-door end, by which the water returns from the upper to the lower cylinders, by two stays at the outer end, and by the lower cylinders being firmly fixed to the seatings attached to the floor of the boat. A further connection exists between the top and bottom cylinders in the great multitude of small tubes curiously but methodically contorted, the ends of which are firmly fixed in the top halves of the upper and lower cylinders. These are steam generating tubes and are perfectly free to move under the influence of expansion or contraction caused by differences of temperature or pressure.

A great feature of tubulous boilers is that they confine a tremendous power in a very small space, which is of course desirable in a small vessel built for speed. The question in the minds of engineers is whether they are going to be durable. The greatest speed ever attained was by a boat built by Herr F. Schichau, of Elbing, Prussia, with locomotive boilers. Yarrow & Co. stick to the locomotive boiler when building to suit themselves, although they have patented a tubulous boiler of their own design that has given satisfaction. In this country for a high-speed boiler we have the one invented by Charles D. Mosher, who built the steam launch Norwood for Norman L. Munro.

The boat to prove the value of triple-expansion engines was the Aberdeen, designed by A. C. Kirk of Glasgow about eight years ago. This was an iron ship 350 feet long, 44 feet beam, 33 feet depth of hold, and with 2,631 indicated horse power. Mr. Kirk is with the firm of R. Napier & Co., and in 1874 he designed the engines of the Propontis, which had three cylinders. The cylinders of the Aberdeen were 30, 45, and 70 inches in diameter, with 4 feet 6 inches stroke.

In 1885 triple-expansion engines were applied to the famous English torpedo boat known as "No. 79," built by Yarrow & Co. She is 125 feet long by 13 feet beam, and is to-day one of the most popular boats in the English service. She is fitted with loco-marine boiler, the grate surface being 30 square feet, while it is estimated that her engines, when working at their best and making 400 revolutions per minute, give 1,000 indicated horse power. With a displacement of 70 tons No. 79 made 23 knots as a maximum speed on her trial trip and maintained a mean speed for two hours of 22.30 knots. To get the enormous power indicated from a single locomotive boiler was considered as showing what advances had been made in boiler construction. Another remarkable feature about the boat was her manœuvring capabilities. She was fitted with one large balance rudder aft with a shape something like those on the Cape Cod catboats, and she completed circles either to port or starboard at full speed, the radius being less than her own length. It took less than a minute to make a circle, and altogether such powers of turning had never before been witnessed. In 1887 Yarrow & Co. built the torpedo boat No. 80 and maintained a mean speed of 22.077 knots on a two-hour trial, but this was hardly so creditable as the speed of No. 79, for the new boat was larger, being 135 feet long by 14 feet beam and had a displacement of 130 tons.

Later in 1887 Yarrow & Co. tried two boats for the Italian Government fitted with twin screws, and had great success in speed. Twin screws had already been tried on a sea-going torpedo boat built in 1886 by Messrs. Thompson for Russia, but their success was not so complete as on the Yarrow boats, one of which attained a mean speed over the measured mile of 24.964 knots and the other of 25.101 knots. These boats were 140 feet long, 14 feet beam, 5 feet 4 inches draught, and 100 tons displacement. There were two locomotive boilers and two sets of compound engines indicating over



THE ARIETE.
Speed 26 Knots.

1,400 horse power combined. The boat that made 25.101 knots had her official trial April 14, 1887, in rough weather.

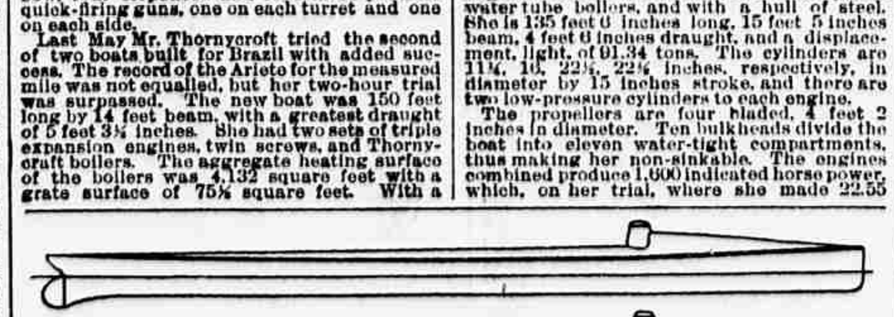
After twin screws came quadruple expansion engines, which, in torpedo boat construction, made their appearance and had a successful trial on the Bathurst, built by Yarrow & Co. in 1890 for the Argentine Government, and also on the Cushing in the same year. The Bathurst attracted widespread attention. She is 130 feet long by 13½ feet beam. There were five other boats all built by Yarrow & Co. to the same contract, and it is interesting to note that they were of the same main dimensions as the Bathurst, but had triple expansion engines, and while their speed on two-hour trials was 23.312 knots, the Bathurst, with quadruple expansion engines, maintained a mean speed on the two-hour trial of 24.426 knots. The Bathurst has only one screw, while the Cushing has twin screws, and consequently two sets of engines and boilers. The cylinders of the Bathurst measure 14, 20, 27, and 38 inches in diameter by 16 inches stroke. Under the same conditions of consumption the average horse power of the five boats, with triple expansion engines, was 1,120, indicated, while on the Bathurst there has been registered 1,230, an increase of 110. The displacement of the Bathurst is 75½ tons, and 12 tons were carried on her official trial when she made 24.426 knots. On the measured mile she made 24.453 knots.

The highest speed in England has been accomplished by Mr. Thornycroft. Since the invention of his tubulous boiler his boats have done remarkable performances. The Thornycroft boiler is light and effective, being especially adapted to maintaining high speed for short runs. Up to last May the famous Thornycroft torpedo boat Ariete, built for the Spanish Government, held the English record for both measured mile and two-hour trials. The Ariete is 147 feet 6 inches long by 14 feet 6 inches beam, with a displacement of 98¾ tons on a draught of water of only 4 feet 11 inches. She has

UNITED STATES TORPEDO BOAT NO. 1—CUSHING.

twin screws driven by ordinary compound engines developing collectively 1,550 indicated horse power, and two Thornycroft boilers. The guaranteed speed was 25 knots on the measured mile and 24 knots on a two hours' trial. On her official trial the Ariete rolled up on the measured mile 26.003 knots, and 24.9 knots on the two hours' run. The torpedo armament consists of two torpedo tubes in the bow, four torpedoes and four three-pounder quick-firing guns, one on each turret and one on each side.

Last May Mr. Thornycroft tried the second of two boats built for Brazil with added success. The record of the Ariete for the measured mile was not equalled, but her two-hour trial was surpassed. The new boat was 150 feet long by 14 feet beam, with a greatest draught of 5 feet 3½ inches. She had two sets of triple expansion engines, twin screws, and Thornycroft boilers. The aggregate heating surface of the boilers was 4,132 square feet with a grate surface of 75½ square feet. With a



Sheer Plan, Showing Wave of the Nibbio at 14, 18, and 26 Knots Respectively.

boiler pressure of 210 pounds the boat made 25.858 knots on the measured mile and 25.387 knots for two hours. The indicated horse power developed was 1,800, and fuel economy under one engine for six hours at a speed of 10 knots was 1.393 pounds of coal per indicated horse power per hour.

In the way of economy in coal consumption M. August Normand of Havre has accomplished some wonderful results. The remarkable feature of the boats of this Frenchman has been their uniformly good work on long runs. They have been able to maintain their high speed long distances. Their boilers, of the locomotive type, are economical, and their engines use steam to the best advantage. On a recent boat 121 feet long, 13 feet 2 inches beam, mean draught of 3 feet 9½ inches, and displacement of 79 tons, only 1½ pounds of coal was consumed per horse power per hour. The engines were of the compound type, and indicated 900 horse power when making 320 revolutions. The cylinders were 17.3 inches, and 27.24 inches by 17.3 inches stroke. The boiler had 317 tubes 8 feet 8 inches long by 1¾ inches in diameter. Its total heating surface was 1,425 square feet, and the pressure was 143 pounds to the square inch, the grate surface being 30 square feet. A speed of 21.087 knots was attained on a two-hour trial, the revolutions running 308 per minute, and the coal consumption 1,802 pounds per hour. Normand lays great stress upon diffusing the products of combustion equally throughout all the tubes in the boiler. His engines are also carried to a high degree of perfection.

It is a difficult matter to obtain any information about the works of Herr Schichau, the Prussian. This is unfortunate, for of the high-speed builders of the world he has reached the greatest prominence and has done more work in the last ten years than any other two firms. The latter may be due to the fact that his boats cost little money, comparatively. His characteristics are simplicity of machinery and refinement of model. Few men have devoted so much time as Herr Schichau to the modelling of vessels. Even at phenomenal speeds which his boats have attained there has been little or no disturbance due to movement through the water. They have been noted for the great speed attained on the horse power developed, this result being accomplished by the refinement of model and efficiency of the propelling power.

The first of a line of successful boats was the Nibbio, built for the Italian Government three years ago. She was 151 feet 8 inches long, 17 feet beam, and 7 feet 6 inches draught. Her displacement fully equipped and coaled was 160 tons, her coal capacity alone being 40 tons, which was enough to allow her to steam 5,000 miles at ten knots per hour. She was fitted with locomotive boilers, two sets of triple expansion engines with cylinders 17 inches, 26 inches, and 37 inches by 17 inches stroke, developing collectively an indicated horse power of 2,200 and driving two three-bladed propellers each 5 feet 11 inches in diameter. Her official trial was made Aug. 22, 1888, and with a displacement of 145 tons, and her engines showing 325 revolutions per minute, this powerful craft developed a mean speed of 26.6 knots, running continuously for three hours. The Nibbio's successor and sister boat, Adler, topped all records for the measured nautical mile, showing on a trial the phenominal speed of 27.4 knots. On a two-hour trial the Adler made 26.55 knots. She was bought by Russia. These boats are divided into twelve water-tight compartments, are fitted with electric lights, as are all torpedo boats nowadays, and are comfortable at sea.

The refinement of model referred to in the Schichau boats is shown clearly by the accompanying cut of the wave formed at various speeds. At 14 knots the Nibbio made no wave at all, at 18 knots it was scarcely perceptible, and at 26 knots it raised only a trifle as compared with other boats.

It will be noticed that the fast boats of Schichau are larger than those built in England, and thus have a decided advantage. As a proof that speed has not been carried to its limit in these craft Yarrow & Co., stand ready to guarantee 28 knots in a 160-foot boat carrying 30 tons. Trials of speed over the measured mile is a method of obtaining a result which has become extinct. All trials are now for two or three hours, the mean speed during this time being taken by the number of revolutions of the engines. A continuous trial of this kind is now considered the only reliable means of judging results, because in a measured mile trial an exceptional result may be obtained by manipulating the machinery so as to store up the power for use only during a short period, while a continuous run for two or three hours shows what may be done in actual practice under normal conditions.

Regarding the use of twin screws Messrs. Yarrow & Co. gave to the writer the following opinion recently: "We have built a few twin-screw boats, but our impression is that in a boat of such small size as even a first-class torpedo boat the increased complication is not compensated for by any additional security. Moreover, it requires a much larger staff of engineers, &c., all of whom have to be provided with board and accomodation, and bearing in mind that the main point for a Government to decide is the best mode of spending a certain amount of money in such vessels, certainly our impression is that it is better to have a greater number of single screw boats of a given size, say 130 to 135 feet in length for the first class, than to have fewer of a larger description, which only exposes a greater area to the enemy's fire. We believe in this respect at the present time most naval authorities agree. Moreover, the difference in speed between a boat 130 feet in length and one of 150 feet, due simply to increased dimensions, amounts only to two knots, but the price is 50 per cent. greater. A Government can buy three boats of a twenty-three-knot speed, having a crew of sixteen men, or two boats having a speed of twenty-five knots and a crew of twenty-three men."

The boats which have been referred to here are only the sensational ones, or those which mark various stages of developement of this type of vessel. There have been hundreds built, and abroad it is now thought little of if a boat rolls off 22 or 23 knots. In this country this speed would create a sensation, indeed, for we have only built one boat, the Cushing, that has actually maintained over twenty-two knots for any length of time. The Cushing registered 22.55 knots on her official three-hour trial, with a load of seventeen tons, and a displacement of nearly 110 tons. The Cushing and the Stiletto, both built by the Herreshoff Manufacturing Company of Bristol, R. I., comprise the United States fleet of torpedo boats at present. The Herreshoffs also built the Henrietta, Say When, and Now Then, but their performances do not entitle them to much consideration.

The Stiletto was launched Feb. 25, 1885, and was bought by the Unites Government for a torpedo boat in the summer of 1888. She is a wooden boat, with a single screw of bronze 48 inches in diameter, with 80 inches pitch and weighing 250 pounds, driven by compound engines, with cylinders 12 inches and 21 inches by 12 inches stroke. The displacement of the Stiletto is 31.8 tons. She is 90 feet long, with 11 feet beam and 2 feet 10 inches draught. Five water-tight bulkheads divide her into six compartments. Her boiler is of the Herreshoff coil type, weighing 10,343 pounds, with a grate surface of 21 square feet. The weight of the engines is 4,275 pounds. On a measured mile trial she developed a speed of 23.195 knots, but on a three-hour trial this fell to 16.75 knots.

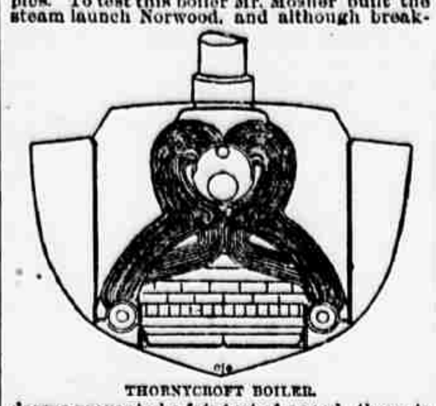
The Cushing is more of a modern craft, being fitted with two sets of quadruple expansion engines driving twin screws, two Thornycroft water tube boilers, and with a hull of steel. She is 135 feet 6 inches long, 15 feet 5 inches beam, 4 feet 6 inches draught, and a displacement, light, of 91.34 tons. The cylinders are 11¼, 16, 22¾, 22¾ inches, respectively, in diameter by 15 inches stroke, and there are two low-pressure cylinders to each engine.

The propellers are four bladed, 4 feet 2 inches in diameter. Ten bulkheads divide the boat into eleven water-tight compartments, thus making her non-sinkable. The engines combined produce 1,600 indicated horse power, which, on her trial, where she made 22.55 knots, was about 14 indicated horse power per ton of displacement.

In the last few months a new firm has sprung into prominence in this country which bids fair to rival the builders of the world in speed. The members of this firm are now quite familiar to the public. They are William Gardner, the naval architect, and C. D. Mosher, the engineer. Mr. Gardner is a graduate of Cornell, having gone from college to John Roach's shipyard, where he spent a year in practical work. Then he went abroad and took a three years' course at the Royal Naval College, Greenwich, after which he remained on the Clyde a year. Mr. Gardner is one of the few Americans who have graduated from Greenwich with honors since the doors of the Royal Naval College were thrown open to young men from America, and is the only one who has started an independent business. The rest are in the Government's employ.

Mr. Mosher is from Amesbury, Mass., and made his début as an engineer when he produced the steam launch Buzz a few years ago. Mr. Mosher made the Buzz himself and drove her a mile in 2 minutes 8 seconds. She is 50 feet long by 6 feet 6 inches beam, and has a draught of 9 inches forward and 16 inches aft. Her boiler is of the locomotive type, with 357 square feet of heating surface, 9 square feet of grate surface, and 150 pounds steam pressure. The engines, with double cylinders, weigh 703 pounds. The diameter of the screw is 32 inches and its pitch is 5 feet.

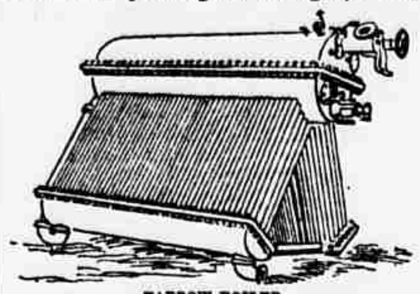
After building this boat Mr. Mosher invented a tubulous boiler, which is the most effective generator of steam yet known, in proportion to its weight and the space which it occupies. To test this boiler Mr. Mosher built the steam launch Norwood, and although break-



THORNYCROFT BOILER.

downs prevented a fair test of speed, there is every reason to believe that if Norman L. Munro would put the boat in the hands of the man who built her she would do some creditable performances. It is evident that Mr. Mosher is the only person qualified for bringing out the Norwood's speed, and it would have been an act of generosity if Mr. Munro had allowed Mr. Mosher to handle the Norwood in her trials last fall, inasmuch as the performances of the boat were to determine in the public mind Mr. Mosher's ability as an engineer. Some personal differences, however, kept Mr. Mosher out of the launch, and she has never shown what she can do.

The displacement of the Norwood is 9 tons and her indicated horse power 400. This is 50 indicated horse power per ton. The dimensions are: Length, 63 feet; beam, 7 feet 3 inches; draught, 18 inches. The frames are of oak and planking of mahogany. The



YARROW BOILER.

boat is fitted with triple-expansion engines, the cylinders of which are 9, 14¾, and 22 inches in diameter by 9 inches stroke. The screw is 35 inches in diameter, two bladed, with 7 feet pitch. The weight of engines is 2,000 pounds, and boiler with water 2¾ tons. The boiler has a steam pressure of 200 pounds. It is 7 feet 3 inches long, 6 feet wide, and 3 feet 6 inches high. The Norwood and her boiler have been fully described in THE SUN; so further comment is unnecessary at this time, although the figures given are interesting for the purpose of comparison.

Messrs. Gardner and Mosher have joined forces in business recently, and their progress is being watched closely by men in the navy, who think the new boat they are building at City Island will be the sensation in the way of speed next year. This craft will be an enlarged Norwood, her length being 78 instead of 63 feet, and displacement 12 instead of 8 tons. The boat will also have quadruple-expansion engines, and is expected to show fifty indicated horse power per ton of displacement.

The next step in the evolution of the torpedo boat will possibly be the application of the Mosher tubulous boiler, but this will depend largely upon the success of the boat building. It is too early yet to say what credit belongs to this country in the way of producing high speed, but up to date surely little is given to the Government. It may be that speed will be developed by the use of private capital, in which case our engineers may be placed on a par with those of foreign countries.

WEEKLY SUICIDES BY A GHOST.

The Unpleasant Drama that a Spook is Playing in a Kansas City House.

From the Kansas City Journal.

There lies in a small brick house on Twenty-third street, just west of old Grand avenue, a woman named Mrs. Albert Ogle, who is suffering from an attack of hysteria, brought about by the unexpected appearance of a visitor from the land of the dead. She is still weak from her illness, and yesterday related to a *Journal* reporter, with some difficulty, a most uncanny story of the cause of her suffering. According to her story the house in which she lives with her husband and little child is haunted. She herself has seen the ghostly visitor, and so, too, has a Mrs. Elliot, who formerly lived in the house.

Six weeks ago the Ogle family moved their chattels into an old brick house, the remnant of what was once a large building, which was cut in two in order to allow an extension of Twenty-third street. Mr. Ogle is a workingman, and is, consequently, but little at home during the day time. Nothing unusual was noticed about the house when first occupied, and, being strangers in the neighborhood, the Ogles were not in a position to learn of the uncanny history of the house. They were not long left in this state of ignorance, however, for the Wednesday following their occupancy of the house Mrs. Ogle was startled to hear coming from an inner room a most tumultuous uproar, which, of itself, startled her, and she was even more affrighted when, upon running to the room to investigate the cause of the scuffling noise, she was unable to discover whence it proceeded.

After the first feeling of fear had disappeared, it dawned upon her mind that possibly she had been deceived in the sound; that it might have been caused by some commotion outside the house. Nevertheless, that night she informed her husband on his return from work of the strange sound she had heard, and there the matter rested.

Nothing further occurred to recall the unpleasant experience until a week from the same day, and at about the same hour, when a second and precisely similar noise was heard. This time Mrs. Ogle was more rapid in her movements, and she gained entrance to the room whence came the noise. The horrible sight which she there encountered all but dethroned her reason. There, to one side of the room and immediately in front of the doorway in which she stood was a man hanging by a rope from the ceiling, his face depicting all the agony of death by strangulation. Instantly the spectre vanished from her sight, neither falling to the floor nor ascending through the ceiling, but melting away.

Thoroughly frightened at the sight, Mrs. Ogle fell to the floor in a swoon and there remained, as she says, for an hour. There was no one in the house but herself, her husband being at his work and her little child on a visit to some friends.

That night when Mr. Ogle returned home his wife related to him her dreadful experience, but he discredited her story, and said that he would himself carefully watch things. A watch, however, was of no avail, for never at night was there any sign of the ghostly visitor.

Things went on in their usual way until another week had passed, and again on a Wednesday, at the same hour, the same noise was heard, and this time Mrs. Ogle determined to run from the house, when she was arrested by her little girl, who ran screaming from the haunted room, crying that a man was there on a chair. Glancing behind her she was more than ever frightened to witness her most unwelcome visitor standing on a chair with a rope around his neck. Suddenly kicking the chair from under him he fell like a condemned murderer through the trap of death.

By this time the family was thoroughly wrought up. Mr. Ogle sent for his mother to remain with his wife in the house, intending to move as soon as his wife should be able to get out of bed. It was hoped that the presence of his mother might have some influence in staying the visits of the ghost, and it was arranged that should the usual Wednesday noise occur again the old lady should rush into the room and investigate it for herself.

True to his appointed time, when both women were in the front room, the stranger commenced his row, and, true to their womanly instincts, neither woman made an effort to reach the scene, one from her inability to leave her bed and the other from timidity. Now the family say they will move out.

Two weeks ago, after she had seen the ghost twice and obtained a good view of him, Mrs. Ogle was sitting by her window sewing. She was surprised to find a pleasant-faced old gentleman surveying the house with a good deal of interest, and more surprised to see him walk up to the door and ask if he could come in, which request was granted. Taking a seat on a stool, the old man bent his face on his hands and began to sob. This, coupled with the recollection of the former uncanny events, began to alarm Mrs. Ogle, and she backed toward the front door.

At this moment the old man looked up and said: "I suppose you wonder why I cry, and I had hoped to conceal my trouble, but the truth is that I am attracted to this house by a sad recollection. My boy, my only boy, died in this house a sad death." Again the old man sobbed, and when calmed he himself described his son, and his description was found to tally exactly with that of the man who every Wednesday afternoon of late has hanged himself in the same house.

SCIENCE AND INDUSTRY.

A recent improvement in rolling mills is announced by which beams can be made of any size and in perfect finish with great facility, and with results as to speed and quality hitherto unattained. The novel and conspicuous feature in this case consists in the simple management of a pair of rolls rotating in a horizontal plane on vertical shafts, these rolls being journalled in such contiguity to the horizontal rolls that their peripheries all turn in to form the transverse outline of an I beam. In this system the horizontally rotating rolls form the top and bottom faces of the I, while the web faces are formed by the horizontal rolls; the housings of the horizontally rotating rolls are also arranged for lateral adjustment, being movable along slide-ways and adjusted by screws. This arrangement is said to be most satisfactorily effected, and this without interfering with the bearings of the horizontal rolls, yet securing perfect concurrence of action at a common point of compression, and subjecting the entire surface to a clear, clean action. The method completely overcomes the difficulty of producing this form of beam perfectly, in very large size, by ordinary rolling mills.

A London journal speaks favorably of what is termed the latest addition to the many products obtained from coal tar, an article described as possessing all the desirable properties of India-rubber. A method has been discovered by a German chemist, it appears, by which, after the tar has been refined by means of sulphuric acid, the residum can be worked up by simple manipulation into a black mass bearing in appearance a very close resemblance to ordinary asphalt, but at the same time having the well-known characteristic of elasticity possessed by India-rubber. On being submitted to continuous and intense heat the material, it is said, can be decreased in bulk some 50 or 60 per cent., under which operation it acquires a great degree of hardness, but at the same time very elastic. In the original or soft state the material is a kind of mineral rubber asphalt, but when dissolved in naphtha it becomes a fine water-proof varnish, suitable for forming a durable and reliable covering, especially for most textile substances.

In a recent paper on steel, read by Dr. Anderson before the Iron Institute, England, he is reported as saying that when a piece of solid iron is thrown into a pot of molten iron or steel, the solid metal at first sinks, which shows that its volume is less than the melted substance, but soon the solid piece becomes heated, which causes it to expand, its volume is increased, and it rises and floats on the surface of the molten mass. The action is remarked as being the same both with iron and steel, and is exhibited at once on simply throwing a piece of iron into melted steel, when it can easily be seen to go down, a movement which might be thought to be due to the impetus attained by the piece of iron in falling that height, but, as a matter of fact, the iron, if placed upon a fork and lowered without any such impetus, would go down; in the course of a few seconds, however, it comes up again, and keeps on expanding until the piece of iron is a considerable distance above the surface of the metal, when it decreases in volume, and, of course, becomes of the same volume as the molten metal which it joined.

By a new process now being introduced the coloring of sheepskins for rugs, &c., has been much simplified, while at the same time the appearance is said to be considerably improved beyond the ordinary article. According to this method the skins, after being tanned in the usual manner, are well watered and nailed flat on a board of corresponding size, with flesh side downward. A bath or beck is made up with the colors required, and the board with the skin allowed to float upon it, so that the wool hangs downward; the beck is then gradually heated up to the temperature necessary for dyeing, care being taken that no waves are produced—the point of consideration in this respect being not to allow full boiling to be reached—and, after the dyeing is accomplished, the skin is rinsed on the board, then loosened and dried. If many skins are to be dried, large, shallow vats and casks are fitted up, upon which may float the boards, the latter to be well dried to prevent warping.

Another ingenious mechanism has been added to the vast number evolved in railroad economics—in the present instance a new kind of clock, the peculiar capabilities of which it is thought present special advantages to locomotive engineers. The dial plate and figures are of large size, as are also both the hour and minute hands, and the operation of these latter constitutes the novel feature in the invention. As a train whirls past a station the hour and minute hands whirl around like a flash to mark the correct time, and a red bullseye flashes into the dial; five minutes later the red light turns green, and in five minutes more the green light disappears. The engineer on the next train following can thus tell exactly how many minutes ahead is the train that precedes him. The clock is a perfect timekeeper, and when the train passes drops the signal light.

Successful tests have lately been made with a new attachment for carding engines, an arrangement designed for the stopping of the machine. The shaft in the upper calender roller is in this instance prolonged a little beyond its bearings, and at its end is affixed a worm gear into a worm wheel, which is mounted on a stud attached to a bracket on the frame. The wheel has a pin affixed to its surface, which engages with a lever acting upon one end of another lever, the other end of this latter lever being bent so as to pass under a catch on one side of the doffer lever, which lever is supported in working position by the catch. The effect of this mechanism is that if the sliver is passed through calender rolls at a proper thickness the worm on the upper calender shaft is held out of contact with the worm wheel. If the sliver is too thin or is entirely absent, the worm folds into a gear and rotates the worm wheel, and thus removes the levers about their centres, releases the catch attached to the doffer lever, and stops the engines.

It appears that very satisfactory results have been reached in experiments made with M. Cailletto's apparatus for producing a temperature of from 90 to 110 degrees, F. below zero, by the expansion of carbonic acid. The apparatus consists of two concentric vessels with a small annular space between them, a spiral coil being placed inside the inner vessel, and this is put in communication with a closed vessel containing liquefied carbonic acid gas. At its lower end the coil is connected with the annular space, and at its upper a stop-cock is fitted. When used, the inner vessel is filled with alcohol, the stop-cock on the carbonic acid vessel is fully opened, and the cock on the spiral partially opened, when the liquid passes slowly into the coil and takes the form of snow. From the coil it passes into the annular chamber, in which are placed pieces of sponge soaked in alcohol, which arrest all the acid that has not become gaseous, while the gas itself passes out of the apparatus through a bent tube. With about five and one-fourth pints of alcohol in the inner vessel, and consuming four and one-half to five and one-half pounds of liquid carbonic acid, a temperature of 95 degrees, F., can be obtained in a few minutes.

A writer in a mechanical journal states that, in the frequent dilemma of the spiral spring of an instrument getting broken, it is much more satisfactory to make one than to send the instrument away for attention. In making them, the best of spring steel wire is to be used, selecting a smooth iron rod the size of the spring to be made, carefully drawing the temper from the metal and fastening the rod and one end of the wire in a bench vise; the wire is now to be wound evenly and closely around the rod until the length of wire required for the spring is obtained, when the rod is to be removed from the vise, and, fastening one end of the spring to the rod and taking hold of the other end, the spring is to be drawn along the rod until the spirals are the correct distance apart. To give the amount of spring wanted, it is to be fastened firmly to the rod. The spring and rod are made red hot, and both quickly plunged into cold water. After drying, rubbed all over carefully with oil, and moved about in the flame of a lamp until the oil takes fire, the spring is thus insured the proper temper. This process is said to be much preferable to the making of such springs direct from tempered wire.

Swedish papers describe a novel kind of construction, termed a locomotive steamboat, built at Kristanstud, for the navigation of a chain of small lakes, separated by falls, the boat being fitted for this purpose with wheels fitting a track, and power may be applied to either the propeller or the driving wheels of the locomotive part of the track; the latter is three feet six inches gauge, with grades of one in thirty-three, and having curves of a radius of one hundred metres.

It is announced that a Welshman has perfected a sewing machine by which the thread is supplied directly from two ordinary spools, and sews through the assistance of a rotary looper; by means of this arrangement, the old style shuttle or bobbin is done away with.